Chapter VII

THE CONTINUUM IS BROKEN

THE HERZFELD YEARS: 1965-1967

On June 6, 1965, Dr. Charles M. Herzfeld became the fifth Director of the Advanced Research Projects Agency. He had been with the Agency for almost four years, having joined DEFENDER in the fall of 1961. He was promoted to Deputy Director of the Agency in 1963. Like his predecessors, Herzfeld had come to ARPA with a strong technical background, including a degree in chemical engineering from Catholic University and a Ph.D. in chemical physics from the University of Chicago. He also brought to the post an impressive career in Federal research and development programs, with military service in the Army's Ballistic Research Laboratory and civilian service in the Naval Research Laboratory and the National Bureau of Standards. In the latter organization he had risen to the level of an Associate Director prior to coming to ARPA. While pursuing this government career, Dr. Herzfeld also gathered considerable teaching experience at the University of Maryland, where in 1957 he became a professor of physics.

Dr. Herzfeld assumed the ARPA Directorship in circumstances quite different from those of his two immediate predecessors. While he shared many background characteristics and attitudes with earlier Directors and was the first ARPA Director who had "risen from the ranks," there was nevertheless a certain aura of dissonance about Herzfeld's ARPA. Conflict increasingly seemed to be the order of the day and in many instances resolution was ephemeral, temporary or simply impossible.

The Setting -- 1965

The major change in the ARPA environment in 1965 was, of course, acceleration of the war in Vietnam and its wide repercussions on the entire DOD environment. At the end of 1964 there were some 23,300 U. S. troops in Vietnam; one year later there were 184,300. Whereas only 147 U. S. Servicemen were killed in Vietnam in 1964, almost ten times as many were killed in 1965. The political situation in Vietnam also appeared to be going from bad to worse. In the first half of 1965 coups and counter-coups came in rapid sequence, ending with the assumption of power in June by the flamboyant and controversial Marshal Ky.

When Sproull had become ARPA Director in 1963 the Vietnam War situation appeared to be under some control and the mood was quite optimistic. As McNamara and Taylor reported to Kennedy on October 2 (following a visit to Vietnam): "... the major part of the U. S. military task can be completed by the end of 1965, although there may be a continuing demand for a limited number of ... training personnel."[1] By the time Herzfeld assumed

the ARPA directorship in 1965, however, the situation had changed considerably. McNamara's comment on February 19, 1965 is illustrative: "the present situation in South Vietnam is grave, but by no means hopeless."[2]

The domestic repercussions of the Vietnam conflict in 1965 were equally as important as the developments in South Vietnam. 1965 was clearly the turning point in the previously good relationships between the academic community and the Defense Department. Prominant university professors and academics led a rash of "teach-ins" in the spring, coupled with campus demonstrations throughout the country. Draft card burning became a common form of student protest and Congress passed legislation on August 13 making the act a Federal offense, a move felt by many to be needlessly retaliatory. Campus-based organization of the March on Washington occupied much of the fall, culminating in the massive gathering on November 27th. By the end of 1965, university-DOD relations had deteriorated to a low level from which it would take many years to recover. ARPA's strength in the early 1960's was, of course, based substantially on its role as a bridge between the two communities.

Vietnam, however, was not the only development in 1965 which had a profound effect on ARPA's environment. In late June the so-called "Camelot" episode hit the headlines. The incident concerned an Army social science project on insurgency and political unrest and was touched off by the questionable activities of a study consultant in Chile who had not cleared his work with the American ambassador. Banner headlines, first in Chile and then in the U. S., seriously questioned the legitimacy and purposes of this work, leading to considerable debate about the ethics of doing behavioral science research for the Defense Department. Repercussions extended from hostile debate between the academic community (and press) and the DOD, to bitterness between DOD and State concerning the latter's handling of the affair. Though ARPA was not involved in this episode, its behavioral sciences effort was threatened by the affair and behavioral science research remained a highly controversial aspect of the ARPA program into the 1970's.

Beyond the above, McNamara decided in 1965 to reject NIKE-X deployment for the foreseeable future. This decision was resented in parts of the Army and the Congress, and was not fully accepted by the Administration, which reversed it in 1967. It also raised questions about the role of ARPA's DEFENDER program and about the ARPA Director's position on ABM deployment. Bitterness over the TFX controversy (F-111) lingered on within the Defense Department; the invasion of the Dominican Republic sparked serious debate over the uses of U. S. military force; the outbreak of Indo-Pakistan hostilities undercut U. S. foreign policy and military assistance programs; sharp increases appeared in Defense budgets, accompanied by great pressure to control R&D expenditures in order to prevent still more rapid escalation (the budget rose from $49.6 billion in FY 1965 to $56.8 billion in FY 1966; 85 per cent of the increase, or $6 billion, was for Vietnam).

1965 was therefore a most difficult year for the Department of Defense
and for the country as a whole. As Senator Dirksen stated, the following
year, "Today what appeared to be a golden glow only two years ago has been
broken by rolls of thunder ... and uncertainty, queasy doubts, bewilder-
ments have spread across the country."[3] His language was florid, but
the point entirely accurate.

DDR&E Perspective on ARPA

The events of 1965 provided a setting for Dr. John Foster's arrival
as Director of Defense Research and Engineering, as well as Dr. Herzfeld's
promotion to Director of ARPA. Appointed in September, three months after
Herzfeld's elevation, Foster's perspective on ARPA must have been influenced
by current events. DOD-university relations had just dropped to an unpre-
cedented low; ARPA was deeply involved in large programs of basic university
research, governed only by quite broad criteria of relevance, e.g., mater-
ials laboratories, the Arecibo radio astronomy facility, a half dozen basic
research institutes funded under DEFENDER, university seismology programs
under VELA, support for advanced computer research, and others. In Vietnam
U. S. forces had shifted from advisory roles to large-scale direct military
involvement, including combat; ARPA's AGILE program was focussed on such
matters as environmental measurements programs and various forms of R&D
support to indigenous forces. The Services were stepping up their criti-
cisms of ARPA/AGILE. The DOD's behavioral sciences research effort was
under bitter attack; ARPA supported a multi-faceted behavioral science
program which touched upon many of the most controversial issues. Serious
budget problems had arisen with the suddenly accelerated Vietnam require-
ments; ARPA was providing as much as four years of advance funding to
universities and tolerating sizeable unobligated balances, accumulated in
all its programs. Criticism of ARPA on these and other grounds was rife at
the time Foster joined the DOD.

Foster confirms that there was a definite "why AFPA?" environment
when he arrived. The feeling existed in OSD, and even within ARPA, that
"ARPA was doing things that were not important, or that somebody else
ought to do, or that were more trouble than they were worth."[4] There
was strong sentiment that ARPA was not playing the role it once had, that
many old assignments had outlived their usefulness, and that a number of
activities were being carried forward simply because of people who had been
there for too long a time. Some of the critics, of course, wanted to do
the job themselves or wanted ARPA's flexibility. McNamara apparently was
disillusioned with ARPA, and Deputy Secretary Cyrus Vance came to advocate
abolishing the Agency. At one stage, the criticism was so intense that
McNamara asked to see every report coming out of ARPA.[5]

According to Foster, who had considerable prior association with
the DEFENDER community and considered himself a supporter of ARPA, the

situation was bad enough that one could not simply tell the critics to go away.[6] He felt that opponents in the Services and in DOD had some legitimate points to make and often had the reputation and contacts to spread uneasiness and discontent in Congress and in the Secretary's office. Indeed he felt "outnumbered by critics" of ARPA who had that kind of horsepower. Nonetheless, comparing ARPA with its competitors, dollar for dollar, over time, Foster said: "I liked what I saw. It all depends on the Director and the people and the charter."[7] He eventually decided that changes were required in all three.

Why had ARPA fallen into this state? In Foster's words, "There was too much toleration of an academic atmosphere" in an era when the DOD and academia had abruptly parted company and top priority was being given to rather precisely defined Defense-relevant tasks.[8] Arecibo-type "good science" projects were looked upon as luxuries: "The Secretary of Defense had a limited budget and could not take on the job of doing science and technology for the whole country and defend it before the country."[9] ARPA's reaction typically (and perhaps naturally) was to dig in and defend its projects rather than make concessions or offer compromise adjustments. This further incensed the critics. ARPA, said Foster, had the image of desiring the "perquisites of academia and the power of bureaucracy," and generated intense resentment as a result.[10] Beyond this there were perceived weaknesses in the Agency's management performance, e.g., its toleration of large unobligated balances ($60 million in FY 1965), overgenerosity to the universities, etc. Moreover, in Foster's judgment, ARPA had failed too often in identifying customers for its research output and in working on a smooth transfer process from the very outset. Hence too many isolated "sandboxes had grown up that needed to be cleaned up."[11] But perhaps as important as anything else was simply a much lower threshhold of irritability throughout the DOD as pertains to roles and missions conflict, budget competition and the like, given increased criticism of and additional constraints on the Defense Department as a whole.

Herzfeld's View of ARPA

In the midst of growing criticism of the Agency and discontent throughout the Department, Herzfeld became ARPA Director with a vigorous, aggressive view of ARPA's role. Herzfeld felt, and told Congress, that "much of the work which ARPA did was the reason why the Army changed from NIKE-ZEUS to NIKE-X"[12] and that much of ARPA's work "induced the Air Force and the Navy to change from the unsophisticated ballistic missiles to the highly sophisticated ballistic missiles being procured now."[13] Herzfeld was a strong believer in the AGILE program, felt that the U. S. was winning the war in Vietnam and argued that ARPA's counterinsurgency R&D activities had a major role to play (and in retrospect he argues that the Southeast Asia situation ended in disaster partially because ARPA/AGILE's views, as he interpreted them, did not prevail).[14] He also believed that the VELA program was of first order national significance, claiming that VELA and

DEFENDER together had made the Limited Test Ban Treaty possible. VELA furthermore had twice "really revolutionized seismology:" first, through its broad support to the field and, second, through the LASA program.[15] He was a strong supporter of the information processing program, feeling that Licklider's commitment to interactive computing had set a true "vision of the next ten years."[16] His presentations to Congress emphasized the spectacular successes of the day -- the VELA satellites, the HIBEX launches, etc. Thus Herzfeld's view of ARPA, echoing Ruina and Sproull, was that of a strong, independent, freewheeling organization: "I think that's why it was such an exciting thing, because we really could do what we thought was new without anybody stopping us."[17] That was one of the problems troubling the new DDR&E.

Perhaps more than any other Director, Herzfeld insisted that ARPA's major role was to respond to "Presidential issues," those of high national policy concern, and again perhaps more than other Directors, he argued that ARPA's strength derived from its direct utility to the Secretary of Defense. In the context of DEFENDER, clearly Herzfeld's priority program, he believed that ARPA's contribution derived from the fact that:[18]

> [I]t was found useful by successive Secretaries of
> Defense and DDR&E's to have a powerful pacesetter
> for the Army program; and their [the Army and ARPA]
> competition, in fact, resulted in a better Army program.

Herzfeld, in reviewing his ARPA years, frequently reiterates the importance of ARPA's presentations to McNamara, and of McNamara's support for ARPA as a strong, independent force (particularly in the context of DEFENDER). The DEFENDER program's knowledge of advanced technology, Herzfeld asserts, was used by the Secretary "very unmercifully to beat the Army over the head."[19]

Herzfeld held strong views on major policy issues like missile defense deployment, nuclear test detection and the conduct of the war in Vietnam. His elaborate Congressional presentations were alleged to have become irritants in ODDR&E and at higher levels. In a sense, the propriety of what appeared to be an ARPA presumption to independent status at the policy level was challenged. Herzfeld concedes that the Vietnam situation was especially difficult to deal with:[20]

> Naturally everybody who didn't agree with what
> we [the U. S. were doing in Vietnam, which in
> those days was mostly Republicans ... obviously
> tried to get me into discussions with them that
> would somehow discredit the policy. This is a
> very difficult sticky-wicket because we didn't
> agree with the policy a lot because we thought

> it was not based on adequate information. And I
> guess if one reads off the testimony carefully
> enough, one can get a lot of that flavor -- it's
> delicate. Occasionally, I guess, we overstepped
> the line, intentionally or not.

Internally, the DEFENDER philosophy which Herzfeld developed and
inculcated in that program while he was its director also reflected his
general order of priorities and orientation for the Agency as a whole:[21]

> Several key points. It's got to be useful to
> the military in the end. On the other hand there
> will never be a uniformed service called ARPA, so
> that [the user] has to be a military service. It's
> got to be useful in 10-20 years, or sooner if pos-
> sible. It's got to affect what the military are
> doing and what the leadership is thinking and doing.
> It's got to address the Presidential issues.... It's
> got to be based on measurement as much as possible.
> Whatever it is. You have to have measurements....
> You want to try and understand everything about
> those measurements, therefore, a lot of theoret-
> ical analysis.... Last and certainly not least,
> you have got to at e   stage understand the
> systems implications somewhat. So some system
> design and some system analysis, including cost-
> benefit analysis, has to go on all the time.

Herzfeld thus argued for military relevance in ARPA programs, but relevance
perhaps achieved over a long time period; for concentration on problems of
first-order national importance; for strong measurements and theoretical
analysis efforts; and for attention to "systems implications." This latter
emphasis, incidentally, was to carry over strongly into the AGILE program
as it developed during Herzfeld's tenure and became a very controversial
aspect of the counterinsurgency research program (particularly in Thailand)
following his departure.

Herzfeld also believed in the research values associated with PSAC
and Ruina and Sproull:[22]

> [T]he administrator of the basic-research enter-
> prise must ... learn to appreciate the rare
> nature of creativity, its importance to society;
> and he must learn to protect and foster it ... the
> administrator must learn to encourage creative
> rebellion, outspoken criticism and radicalism in
> the ranks. He must see the fine line between
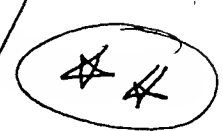
> utter chaos (which paralyzes) and mild chaos
> (which makes for creative turbulence). In sum,
> he must learn that administration is not a sci-
> ence, but is itself a form of creative art.
>   Society must learn to live with this radical --
> the creative scientist doing basic research. It
> must support him -- rather well, in fact -- and
> buy him expensive "toys" whose use society cannot
> understand ... most important, it must believe in
> him and in his contribution to society, a contri-
> bution which it can never fully understand.

Alongside his vigorous defense of a strong, relatively independent
ARPA and the pursuit of excellence in research, Herzfeld also placed
great stress on the quality of ARPA staff and contractors (as did his
immediate predecessors). Herzfeld claims that he devoted up to one-third
of his time to personnel matters and recruiting. Furthermore, he placed
great value on "what he termed "helper" organizations -- JASON, RAND, IDA,
and other so-called "think tank" contractor groups that enjoyed a special
sort of consulting relationship with the Department of Defense during the
1960's. The capabilities of these groups were tapped very heavily by
Herzfeld to supplement the small ARPA technical staff in numerous areas.

Herzfeld's ARPA was an aggressive ARPA. He was dedicated to the
resolution of major issues and as he took command ballistic missile defense,
penetration aids, counterinsurgency, and nuclear test detection offered a
full menu. Herzfeld was convinced that ARPA could produce winners in all
of them; however, in the relatively short time that he served as Director
-- 22 months -- he and the Agency rapidly lost the ability to resonate
well with the personalities, policies and circumstances which crowded in
upon them. In retrospect, for all its vaunted flexibility, ARPA was
unable to change as quickly as the environment within which it had to
operate. Dr. Herzfeld had to deal with the most difficult, intransigent
set of pressures since the end of the Roy Johnson period.

PROGRAMS IN THE HERZFELD PERIOD

An overview of ARPA programs in the Herzfeld period gives a first
impression of strength and accomplishment, but reveals some disturbing
features on closer inspection. At the time Herzfeld became Director,
ARPA had reached its post-space budgetary peak -- just under $300 million --
and all of the major programs of the Sproull period continued to flourish
(see Figure VII-1). DEFENDER budgets remained near $125 million; VELA was
funded at approximately $50 million; AGILE, its budget bolstered by the
DOD's increased Southeast Asia commitments, rose to nearly $30 million;
Materials Sciences and Information Processing were funded at approximately
$20 million each; the new Advanced Sensors office grew to over $10 million
and Behavioral Sciences to almost $5 million; even the general area of

Figure VII-1

PROGRAM BUDGET HISTORY DURING THE HERZFELD PERIOD
($ millions)

	FY 1966	FY 1967	FY 1968
Appropriations Requests	277	263	254
Actual Budgets	274	263	240
Commitments To Agents	280	270	232
Contract Expenditures[1]	267	275	284
Requests By Program:			
DEFENDER	127	119	118
VELA	59	49	50
AGILE	30	29	27
Materials	28	29	19
Information Processing	19	18	19
Behavioral Science	4	5	5
Advanced Sensors	5	10	12
Technical Studies	9	9	9

[1] Added to illustrate that while budgets declined in the period, level
of effort on contracts actually increased. A major issue relating to
the budget slippage during the period was that ARPA had large unobli-
gated balances of funds. The program was maintained at a stable level
through utilizing accumulated balances of previous years.

"technical studies" grew to nearly $10 million. On the other hand,
Herzfeld's last budget request as Director (FY 1968) dropped from earlier
levels of $270-$290 million to $254 million, reflecting Vietnam budgetary
pressures and perhaps also some difficulties in maintaining program momentum.

Among the features of the Herzfeld ARPA which provided some cause for
concern was the extent to which offices were tied up with rather expensive
past commitments. PRESS, for example, was still providing valuable data
and analysis output, but the maintenance and continued upgrading of the
facility was a major burden; nor could it hope to repeat the initial
impact which had been achieved in a near vacuum of sophisticated reentry
measurements. Continued launches of VELA Satellites likewise brought new,
improved capabilities, but at substantial expense and with no hope of
replicating their extraordinary initial success story. The Materials IDL's
were now part of the university establishment, absorbing some $17 million
per year on a continuing basis. The innovative Project MAC at MIT was
increasingly preoccupied with its expensive MULTICS second-generation time
sharing system. Even AGILE had an ever-growing infrastructure to support
in the form of its field office operations.

If ARPA's flexibility was restricted by the legacy of its past suc-
cesses, there were also a substantial number of relatively new initiatives
which at the time or later generated considerable misgivings, and many of
these efforts were also quite expensive. In Information Processing Tech-
niques, the commitment to build the giant ILLIAC IV computer has been
questioned up to the present. In VELA, the Large Aperture Seismic Array
program failed to reach its more ambitious systems objectives and was
reduced to a rather costly research program; the underwater array program
also proved a technical disappointment. The Materials Sciences "coupling
program" failed to become the success anticipated. The Advanced Sensors'
office, its operation greatly complicated by its relationship to intelli-
gence applications, was questioned from the beginning. A large Rural
Security Systems Program established in Thailand under the AGILE banner
became a fiasco in the next few years.

Between commitment to older programs which had passed their peak
impact and newer programs which proved considerably less successful than
earlier initiatives, the ARPA effort appeared to lose a substantial
measure of its forward motion and drive. With this, it also lost some of
its ability to go to the DDR&E or the Secretary with the kinds of dramatic
accomplishments which buttressed the Agency's reputation and stature.
This is not to say that the ARPA program as a whole was not strong in
numerous ways -- PRESS was still very significant, Pen Aids work flour-
ished, ARPA remained in the forefront in advanced information processing

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* Due to the highly classified nature of many of its programs, Advanced
  Sensors is described only in outline form in this report. Discussion
  is omitted in this section and continued in the program descriptions
  of the Rechtin period.

technology, VELA continued to make major contributions to seismology and the satellites performed beautifully, etc. The Agency was, however, in the almost impossible position of having to sustain established fields of endeavor and yet "live up" to a reputation originally set in the context of filling important technical vacuums, where results frequently were obvious and dramatic. The earlier "primitive" fields -- reentry physics, modern radar, seismology, interdisciplinary materials research, advanced computer sciences, etc. -- were no longer primitive, largely due to ARPA support. Now ARPA was obliged to sustain them, and new fields of equal importance and equal need for nourishment were not easy to find.

DEFENDER

The DEFENDER program structure in 1965 had changed little from that of 1963. The categories of penetration aids, electromagnetics (mostly advanced radar research), mechanics (including predominantly HIBEX), and missile phenomenology (FRESS, AMOS, etc.) remained the same. The category General Research had been changed to Applied Research, implying greater military relevance, but it still contained about the same project mix, e.g., Arecibo, nuclear effects studies and university institute programs. A new category of Systems Analysis was formed which essentially encompassing various broad studies which were previously described just as "studies." The reentry physics-missile phenomenology work still formed the largest part of the program and the DEFENDER effort continued to be funded at a basically stable level (just under $125 million). A quick glance at the 1965 DEFENDER therefore reveals little change from the program at the time Sproull became Director in 1963.

There were, however, a number of significant developments occurring in DEFENDER as Dr. Herzfeld became Director. One major accomplishment was completion of the massive "Pen-X" study in July 1965. The study is said to have had a major impact on advanced penetration concepts and recommended changes in emphasis in ARPA's program in specific technical areas. According to Dr. Ben Alexander, the study Director, Pen-X reinforced both the Air Force's interest in MIRV's and the AEC's interest in small warhead development and may have considerably stimulated developments in both areas.[23] In layman's terms, the study essentially concluded that the tradeoff between small multiple warheads and a single larger warhead accompanied by sophisticated decoy systems was favorable to the former. Or, as Herzfeld put it "Pen-X proved that, for all practical purposes, multiple warheads are better than decoys [and] that's why MIRV's are around fella's."[24]

ARPA provided the funds and general direction, and often much of the impetus, for a series of these so-called "X" studies at crucial points in the evolution of the U. S. scientific/technological community's thinking about missile defense. Each has had rather far-reaching impact on subsequent policy choices. Customarily they involve dozens of

top-flight scientists, last for months and may cost several million dollars
Herzfeld has described them as "sort of mammoth study orgies."[25] And
he believes that nothing short of an ARPA can orchestrate them:[26]

> [T]here is no direct funding out of OSD to
> speak of [for something like this]. And there
> certainly isn't any [place] where you can get
> a good quality control for something that's this
> technical. See, again, it's the issue of how do
> you know that the money is spent right, which faced
> a Brown, a McNamara, a Ruina, a Foster. The
> answer is let ARPA run it.... [I]f it's a program
> that involves maybe ten organizations, a hundred
> technical people, all three Services in a major
> way, for a year's important study, that you plan
> to use the results of, well you'd better get it
> right. And you really, in terms of justifying
> the expenditure to yourself and others, have to
> know that it is being done right. Where do you
> go, even now, if you sit in OSD, and you have
> that kind of problem? ARPA. That's one of the
> things that ARPA is good at. Always has been
> and always will be, I trust, as long as there
> is one.

ARPA's role in advanced radar development also continued to evolve.
The ADAR program had essentially developed from an advanced phased array
components program to a prototype model development program, with the
latter actually initiated in April 1966. During the same period, the
HAPDAR low-cost phased array became operational at White Sands (in a
receive-only configuration in October 1965 and full radar mode in June
1966).

New instrumentation radars for the PRESS program were also in develop-
ment or in planning, and old equipment was modified and upgraded. Notable
among these developments were the new ALCOR (ARPA-Lincoln Coherent Observ-
ables Radar) and ALTAIR (APRA Long Range Tracking and Instrumentation
Radar). ALCOR was a high resolution radar with a capability to measure
the length of reentry bodies and/or satellites. It made it possible to
investigate length measurement as a BMD discrimination technique and also
made a central contribution to intelligence applications in space object
identification (SOI). This latter area of investigation has continued
in ARPA following the DEFENDER transfer. The ALTAIR radar extended PRESS
capabilities in the UHF and VHF ranges. Herzfeld had little patience with
those who considered PRESS investments (cumulatively $250-$350 million)
expensive. In his mind the $10-$20 billion U. S. investment in strategic
weapons systems in fact depended on the PRESS measurements system for

reasons: the generally rough period ARPA went through in 1965-1966; the evolving over supply of Ph.D's in materials; and the fact that the program was "battered at by ants," meaning a succession of small pro-blems, mediocre contractors and the absence of strong-willed people with an interest to try something new.[69] In any event, doubts were beginning to crop up vis-a-vis the coupling program in the latter part of Herzfeld's period which reinforced the problem image created by the IDL situation.

The stage was thus set for a major program reorientation on Dr. Rechtin's arrival.

Information Processing Technology

During the Herzfeld period, the information processing technology program continued to be a strong and relatively noncontroversial effort, still predominantly oriented toward basic and applied research. The program was, however, shifting gradually toward "6.2" development efforts, as suggested by three undertakings: development of a second generation time-sharing computer system (MULTICS) at MIT, commitment to build an immense parallel processing computer (ILLIAC IV), and initial investigation of means of interconnecting or "networking" geographically separate computers (ultimately crystalizing into the ARPA Network or ARPANET project). In retrospect, the IPT office during the 1965-1966 time period appears to be in a transitional state between the research emphasis of the Ruina-Sproull period and the exploratory development orientation of the Rechtin-Lukasik years.

Interestingly, the gradually increasing emphasis on defense rele-vance which had began to effect the other research-oriented offices appears not to have affected IPT to nearly the same extent. Broad-based computer research simply was accepted as relevant on its face. ARPA's description of the FY 1966 IPT program, for example, justified the program on grounds that the DOD was a very large user of computer technology rather than stressing any unique military applications. In fact, it was boldly asserted that DOD was a beneficiary of the research largely in a secondary sense, that is, IPT's work would improve the quality of products of commercial manufacturers and DOD would ultimately benefit as a buyer of such products:[70]

> The Department of Defense utilizes more than
> two-thirds of the Federal Government's computing
> resources. The ARPA Information Processing Tech-
> niques Project is directed toward creating tech-
> niques, languages and procedures in the use of
> the electronic computer to do a better job. This
> project has been directly responsible for the
> development of multiple access, time-shared computer

> systems. The first of such systems to be made
> available to the public are being marketed this
> year by the commercial manufacturers. This new
> way of using computers allows an individual with
> a problem to use the computer in a conversational,
> interactive way, thereby permitting new approaches
> to solving a variety of problems that heretofore
> were not amenable to the computer. This part of
> the ARPA program has demonstrated that a single
> computer system can serve dozens of human users
> concurrently such that each user has at his
> continuous command the resources of the entire
> computer. The economic payoff of this research
> is obvious.

The point here is that the revolutionary impact of rapid developments
in the computer field in the mid-1960's were so obvious that very broad
criteria of Defense relevance were still acceptable.

During this period, the IPT program tended to maintain the university
focus established by Dr. Licklider, who had now left ARPA and was succeeded
as IPT director first by Dr. Ivan Sutherland and subsequently by Mr. Robert
Taylor. Project MAC retained its position as the largest and most visible
of the university efforts, though major projects were underway at numerous
other institutions. Even the primary new "hardware" development program
of the period -- the ILLIAC IV computer -- was supported through a
university, the University of Illinois.

The MAC program, as noted above, was highly colored by the develop-
ment of the MULTICS advanced time-sharing system, though a very wide-
ranging research program was actually supported. MULTICS itself was a
subject of some controversy throughout the period and into the late
1960's, as the system proved more costly than anticipated and encountered
numerous delays before going into operation.[71] Dr. Licklider, who
later became director of Project MAC, attributes these problems to the
machine being "over-designed," due partially to the constant flow of
very advanced concepts from the MIT community, and admits that MULTICS
came close to becoming a fiasco.[72] It emerged, however, as the most-
sophisticated and "in many ways the best" operational time-sharing system
in existence and is now being sold commercially by Honeywell. MULTICS
is also perhaps the only operational time-sharing system which could be
modified to meet military secuirty requirements, an issue which has come
to be of increased interest to DOD and IPT in recent years. Despite
early difficulties, therefore, MULTICS is now considered one of IPT's
success stories, though with not quite the impact of the first MIT time-
sharing system.

Extensive research was supported during the Herzfeld period on
advanced programming and computer languages. ARPA, for example, under-

wrote the development of "higher level" computer languages such as LISP
and Formula ALGOL, which enable the compter to address problems which
could not be solved by the traditional FORTRAN and COBOL languages.
Computer graphics (a special interest of Dr. Sutherland, who was a
prominant innovator in this field) also received considerable emphasis
during the mid-1960's. The IPT program produced a very long list of
highly technical software developments which cannot be meaningfully
described here, but which have had lasting impact on advanced computer
technology. According to one MIT computer scientist (an acknowledged
leader in advanced computer technology in this country), the ARPA
projects in this and subsequent periods "probably contributed more than
all the other computer science laboratories in the country in the most
advanced things ... it's almost impossible to think of anything im-
portant that has happened anywhere else."[73]

Initiation of ILLIAC IV. While Herzfeld sustained the thrust of
earlier information processing work, highlighted by work on the second-
generation MAC time-sharing system, the IPT program also moved in new
directions. Notable among these initiatives was the development of a
program in "parallel processing" which was to prove one of ARPA's more
controversial endeavors.

Illustrating that ARPA still retained responsiveness to outside
ideas, the parallel processing effort was initiated on the basis of an
unsolicited proposal, "Experimentation in Parallel Computation," sub-
mitted to ARPA by Dr. D. L. Slotnick in October 1965.[74] Dr. Slotnick
was an innovative computer scientist at the University of Illinois who
was associated with the design of unique computer architectures. His
proposal to ARPA involved the concept of linking several arithmetic
computer processors to a single control unit (rather than the traditional
one-on-one architecture), designed so that the arithmetic processors
could work on parts of a calculation simultaneously or "in parallel."
By enabling several functions to be performed concurrently rather than
sequentially it was argued that the power and speed of the computer
could be increased dramatically. The concept, however, was highly
controversial on several grounds: the feasibility of developing the
required hardware and achieving high levels of reliability with it, the
complexity of the required programs, and the existence of a sufficiently
large class of problems suitable to parallel computation to make such
a machine development worthwhile.

To support Dr. Slotnick's proposal was thus something of a "high
risk" proposition, given the doubts of many contemporary experts. It
also entailed a substantial investment to design and build a prototype
machine. Should the concept prove out, however, there would also be
high payoff because the computer development program eventually approved
promised an increase in "speed of data processing from 500 to 700 times
over present computers, and over 100 times faster than any computer known

to be in development."[75]

ARPA's speed in acting on this program is indeed impressive. On October 15, 1965, eight days after the formal proposal was submitted, a program plan was developed. One week later an ARPA Order to initiate the program was signed, with the Rome Air Development Center as agent. In January 1966 the University of Illinois requested bids from industry to investigate the feasibility of developing the machine's architecture. The Illinois contract with ARPA, which was designed to develop hardware design criteria, software and languages, became effective in April. Three industry contractors (RCA, Burroughs and UNIVAC) were selected at about the same time to provide inputs on machine design. By the ertl of the year this "Phase 1" effort had progressed to the point where the three industrial contractors were asked to submit detailed proposals for machine development. Burroughs was awarded the construction contract in January 1967, with total program cost estimated at $21 million. In just over a year the parallel processing effort had moved from an unsolicited concept paper through a preliminary design phase to commitment to a multi-million dollar hardware development project. ARPA had clearly not lost its flexibility and ability to take initiatives.

Behavioral Sciences

The ARPA behavioral sciences program in the Herzfeld period consisted of five major project areas -- teaching and learning (primarily computer-aided instruction); human performance (including research on psychological factors relating to memory, hearing, and response to pain); human communication (with emphasis on cross-cultural communication); bargaining and negotiation (including gaming and simulation of international conflict); and behavioral science process and theory (primarily studies of cultural and social change).

What is perhaps most interesting about the behavioral science effort in this period (roughly a $4 million annual program) was that it managed to sustain a significant social science research effort concerning foreign cultures during a time of very unfavorable conditions. The so-called "Camelot" episode, mentioned above, occurred in June 1965. Camelot was to have been a large Army-sponsored study of internal conflict, with case studies in a number of developing countries around the world. When a questionably conducted consultant's visit to Chile raised a political furor in that country and the U. S. the project was cancelled, a storm of academic protest arose over Defense sponsorship of social science research and laborious clearance processes were put into effect for those behavioral science projects which were continued abroad. The Camelot episode also served to reinforce traditional State Department prejudices, namely, tending to rely upon the accumulated experience of foreign service officers as the source of knowledge on a foreign culture. Beyond this, the Camelot episode brought Defense Department

research efforts in behavioral science under much closer Congressional scrutiny. Congressional questioning was also increased due to behavioral science research being performed in the Vietnam context, including ARPA projects undertaken as part of the AGILE program.

Despite the unfavorable environment, the Behavioral Sciences office was able, throughout the mid-sixties, to maintain a significant program of research relating to foreign cultures. Post-Camelot initiatives involving research in sensitive foreign countries were undertaken -- e.g., a study undertaken by Kalamazoo College in Peru. The new project clearance requirements were followed (necessitating, for example, State Department and U. S. Embassy approvals) and other steps were taken to reduce possible tensions arising from such research. The ARPA program insisted on certain standards: unclassified basic research, explicit acknowledgement by the researcher of DOD funding, host nation government approval of the project, a host national university project co-director, publication of all results in the open literature in both languages, and if possible provision for the host nation co-director to be present in the U. S. for the period when results were written up. Some of the more sensitive aspects of field research, such as attempts to forecast governmental stability, were never considered legitimate subjects of inquiry in the program. ARPA also was eager to have U. S. universities accept greater responsibility for the behavior of their researchers while in the field, but this was hard to achieve. It was a model set of principles for government support of foreign area research.

What apparently kept this line of research going in the face of new constraints and criticisms was the aforementioned deeply held belief of the Behavioral Science office director, and others in ARPA and OSD, that the U. S. military was being thrust into a variety of involvements with foreign societies, and that research could be of value in improving understanding of them -- perhaps to the extent of enabling the military to fulfill its assigned roles more effectively. There was an underlying feeling that the military had not sought these overseas roles but rather was at the mercy of foreign policy decisions made elsewhere, and developing an improved base of knowledge on foreign cultures was almost viewed as a form of self-protection. Dr. Foster was publicly a strong defender of a research effort on foreign cultural and social factors, and supported such programs in the face of increasing Congressional opposition well into the late 1960's. In May 1968, for example, he still argued the case made during the Herzfeld period:[76]

> We are interested only in those so-called cultural and social factors that have a clear relationship to Defense activities. Today this spans a great range because the Defense Department shares responsibility for many international activities.

In the last decade, U. S. forces have been
involved -- at quite different levels -- in con-
flicts in Lebanon, the Dominican Republic, and
Vietnam. No matter what one's view of these in-
cidents, DOD research must help provide some
understanding of the limits on the effectiveness
of various military options in situations in which
we consider the use of military force.

There are many concrete reasons for this re-
search. Some military personnel are in continuous,
close contact with foreign leaders and with foreign
military and civilian populations. These contacts
include participation in negotiations (e.g., Korea);
training and advisory activities in the U. S. and
abroad; and civic action programs in several regions
of the world. Defense personnel, as well as all
other Americans officially involved, must under-
stand the cultural environment in which they serve
to do their work most effectively.

Throughout Dr. Herzfeld's tenure as ARPA Director and, in fact,
throughout the life of the program, ARPA-supported research relating
to foreign cultural and social factors encountered no "Camelot"-type
political embarrassments. Increasing difficulties in supporting
university researchers arose, however, with growing disenchantment with
the Vietnam war. Ultimately these difficulties, combined with constant
problems in explaining the program to Congress and Vietnam budget
pressures (behavioral science university "forward funding" was dras-
tically cut in FY 1968, along with similar cuts in the materials pro-
gram) simply wore down enthusiasm for the effort. As will be noted,
the program was reorganized under Dr. Rechtin to eliminate research on
foreign cultures and research with direct foreign policy implications.
While it lasted, this controversial part of the behavioral sciences
program appeared to be sincerely motivated and the research performed
seems to have been accepted as of reasonable quality (whereas the
quality of behavioral research under AGILE was subject to considerable
attack). In the end, foreign-oriented behavioral research fell victim
to a negative environment for which ARPA held little responsibility but
could not overcome.

HERZFELD'S DEPARTURE

Herzfeld left ARPA in March of 1967. He had served as ARPA Director
for less than two years, but was a powerful influence on the Agency from
the date of his appointment to the DEFENDER staff in late 1961. Like
his predecessors, Herzfeld had planned to leave the Agency well in advance,
but unlike Ruina or Sproull he left in an atmosphere of some discord and
with no obvious successor. Throughout most of a stormy 1967, ARPA was

Symptomatic of ARPA-DDR&E relations just prior to Herzfeld's departure were a series of "Memoranda of Understanding," prepared in late 1966. Covering the several major program areas in ARPA, each memoranda reviewed the ARPA effort in that program vis-a-vis work performed in the Services and reached agreement on the scope and direction of current and planned ARPA programs. These agreements were "negotiated" between the responsible ARPA program directors and the DDR&E staff members involved in the technological areas concerned, then signed by the ARPA Director and the Deputy DDR&E responsible for that area (in Materials Sciences, for example, the agreement was signed by the Deputy DDR&E, Research and Technology). Herzfeld defended these agreements on the ground that there had been "no ARPA/ODDR&E relationship," good or bad, for some time prior to Foster's arrival. Given the lack of interaction, the Deputy DDR&E's were not using ARPA's talents and results sufficiently, which was bad for them.[79] By the same token, ARPA was ignorant of DDR&E problems and hence the ARPA program was not as responsive as it could have been to ODDR&E. Thus Herzfeld says he saw the agreements as meaning of acquainting the DDR&E Deputies with the details of the ARPA program.

Nevertheless the agreements implicitly reflected a distinct reduction in ARPA's status. Whereas it had previously been a tradition that the DDR&E controlled ARPA through the DDR&E's personal relationship with the ARPA Director, and not through subordinate staff members (Sproull and Ruina were both insistent on this relationship), ARPA now sought the written agreement of DDR&E Deputies for each major program. It appeared as if ARPA felt it needed "protection" from ODDR&E criticism and hoped to overcome it by formal written agreement. The memoranda subsequently came to be known informally within ARPA as "the Treaties," and indeed they closely resembled treaties in form and substance, with ARPA being the weaker signatory.* They were to be cited by Herzfeld's successors as dramatic evidence of the low state to which ARPA-DDR&E relationships had fallen as ARPA approached the end of its first decade. By the time Herzfeld left, the ARPA budget was being reviewed, line item by line item, in the DDR&E's staff meetings for the first time in the

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* An example of the "Materials Treaty" wording:[80]

> We have agreed that the IDL Program should be more
> oriented to DOD problems. We have further agreed
> that the manner in which we approach the universities
> to secure this needed balance of orientation is subject
> to further discussion between us. However, we have
> set an initial goal of 50% as the ratio between problems
> directly related to DOD needs and those with a more
> tenuous connection. We both recognize that the re-
> orientation must be evolutionary.

Agency's history. When Rechtin arrived as Director after the seven
month Franken interlude, he found Foster trying to control the ARPA
program by deferring as much as 90 per cent of its budget and per-
sonally interviewing and approving recruits for the ARPA staff.[81]

Herzfeld was exceedingly proud of ARPA and its accomplishments
and he viewed the Agency as an essential component of the Office of
the Secretary of Defense. He believed it should be used to take on
"Presidential issues" on the Secretary's behalf and he clearly felt
that: (a) such issues existed and (b) were urgently in need of atten-
tion by a non-Service agency. He interpreted attacks on ARPA programs
as attacks on the Agency itself and its OSD role. This has been a
normal reaction by ARPA staff throughout ARPA's history, but was bound
to occur in 1967 when the Services again were hostile, the Secretary
and Deputy Secretary found ARPA an irritation, and the DDR&E was making
it clear that he felt it probably was time to transfer out DEFENDER,
VELA and the Materials Sciences work -- the stalwarts of the ARPA
program for a decade -- and to transform AGILE into a quick-fix program
responding to the needs of U. S. forces in Vietnam (which is some ways
reinforced Service aggravation with ARPA). Ironically, Foster may
have been more "pro-ARPA" in an institutional sense than either York
or Brown, but he had come to believe that ARPA's survival depended on
a programmatic house cleaning and a decided reorientation in purpose
and outlook. Herzfeld disagreed and refused to budge. In some sense,
then, one can argue that by insisting on his views he and the Agency
became a sort of threat to the DDR&E -- an independent director with
a quasi-independent agency and a $250 million plus budget as a base,
making it clear that he was not prepared to react positively to new
signals from the top. On the other hand, the DDR&E's increasingly
obvious superior status position and determination to reshape ARPA,
persuaded Herzfeld to leave. ARPA very nearly collapsed in the six
months after his departure and some would argue that its subsequent
"revival" took place at the price of sacrificing much that had been
considered the heart and soul of the Agency in years past. Others
will claim that it was a remarkable survival performance in the face
of tremendous odds. Whatever the correct interpretation, Herzfeld's
tenure marked the dividing line between old and new.